Journal of Arrhythmia 28 (2012) 61–64

Contents lists available at SciVerse ScienceDirect

Journal of Arrhythmia

journal homepage: www.elsevier.com/locate/joa

Case Report

A 6-year-old boy with secondary long QT syndrome

Kanami Kojo, MD[a], Masao Yoshinaga, MD, PhD, FAHA[a,*], Yu Kucho, MS[a], Daisuke Hazeki, MD[a], Yuji Tanaka, MD, PhD[a], Michiyo Mizota, MD, PhD[b]

[a] Department of Pediatrics, National Hospital Organization, Kagoshima Medical Center, 8-1 Shiroyama-cho, Kagoshima 892-0853, Japan
[b] Department of Pediatrics, Imamura Hospital, Kagoshima, Japan

ARTICLE INFO

Article history:
Received 4 July 2011
Accepted 7 October 2011
Available online 8 March 2012

Keywords:
Secondary
QT interval
Aldosteronism
Children

ABSTRACT

Secondary long QT syndrome (LQTS) is caused by several drugs, cardiac conditions, and noncardiac conditions. One of the main metabolic causes is hypokalemia. We experienced treating a boy with secondary LQTS due to primary aldosteronism. The boy had been followed annually since he was 6 years old because his resting electrocardiogram (ECG) showed a prolonged QT interval. When he was 9 years old, he developed general fatigue and myalgia. The QT interval in his resting ECG became longer and serum data indicated rhabdomyolysis. The aldosterone level was high and renin activity was low. He was diagnosed with primary aldosteronism. When we, pediatricians, see children with LQTS, we are apt to think that their condition is congenital in nature. However, secondary or acquired LQTS should be always taken into consideration and be excluded not only in adults but also in the pediatric population.

1. Introduction

Hereditary long-QT syndrome (LQTS) is characterized by prolonged ventricular repolarization and an increased risk for ventricular tachyarrhythmias (torsades de pointes) and sudden cardiac death [1]. It is caused by mutations that encode critical channel pore-forming alpha subunits and channel-interacting proteins [2,3]. LQTS is secondarily caused by several drugs (e.g., antiarrhythmics, antihistamines, psychotropics, and antimicrobials), cardiac conditions (myocardial infarction, heart failure, cardiomyopathy, hypertension, and bradycardia), and noncardiac conditions (diabetes mellitus, anorexia nervosa, metabolic causes, intracranial hemorrhage, and hypothyroidism) [4]. One of the main metabolic causes is hypokalemia.

2. Case report

A 6-year-old boy was referred to our hospital for the investigation of an electrocardiographic (ECG) abnormality in May 2006. Prolongation of the QT interval was discovered during a school-based screening program held in our city. His resting ECG showed a corrected QT interval (QTc) of 0.505, by Bazett's formula, and 0.475, by Fridericia's formula. Serum chemical data were not obtained. Thereafter, he visited our hospital annually.

He was unable to keep up with his peers since April 2008. In August 2008, he developed general fatigue and myalgia and visited the hospital on August 31, 2008. His resting ECG showed a QTc by Bazett's formula of 0.665 and by Fridericia's formula of 0.634 (Fig. 1a). Serum chemical data indicated rhabdomyolysis (Table 1). His aldosterone level was 1290 pg/ml, and renin activity was < 0.1 ng ml^{-1} h^{-1}. Computed tomography and magnetic resonance imaging did not show any tumor-related change or hyperplasia in his adrenal gland. He was diagnosed with primary aldosteronism. Potassium and spironolactone were administered. Before the administration, his blood pressure

* Corresponding author. Tel.: +81 99 223 1151; fax: +81 99 223 7918.
E-mail address: m-yoshi@kagomc2.hosp.go.jp (M. Yoshinaga).

1880-4276/$ - see front matter © 2012 Japanese Heart Rhythm Society. Published by Elsevier B.V. All rights reserved.
doi:10.1016/j.joa.2012.02.009

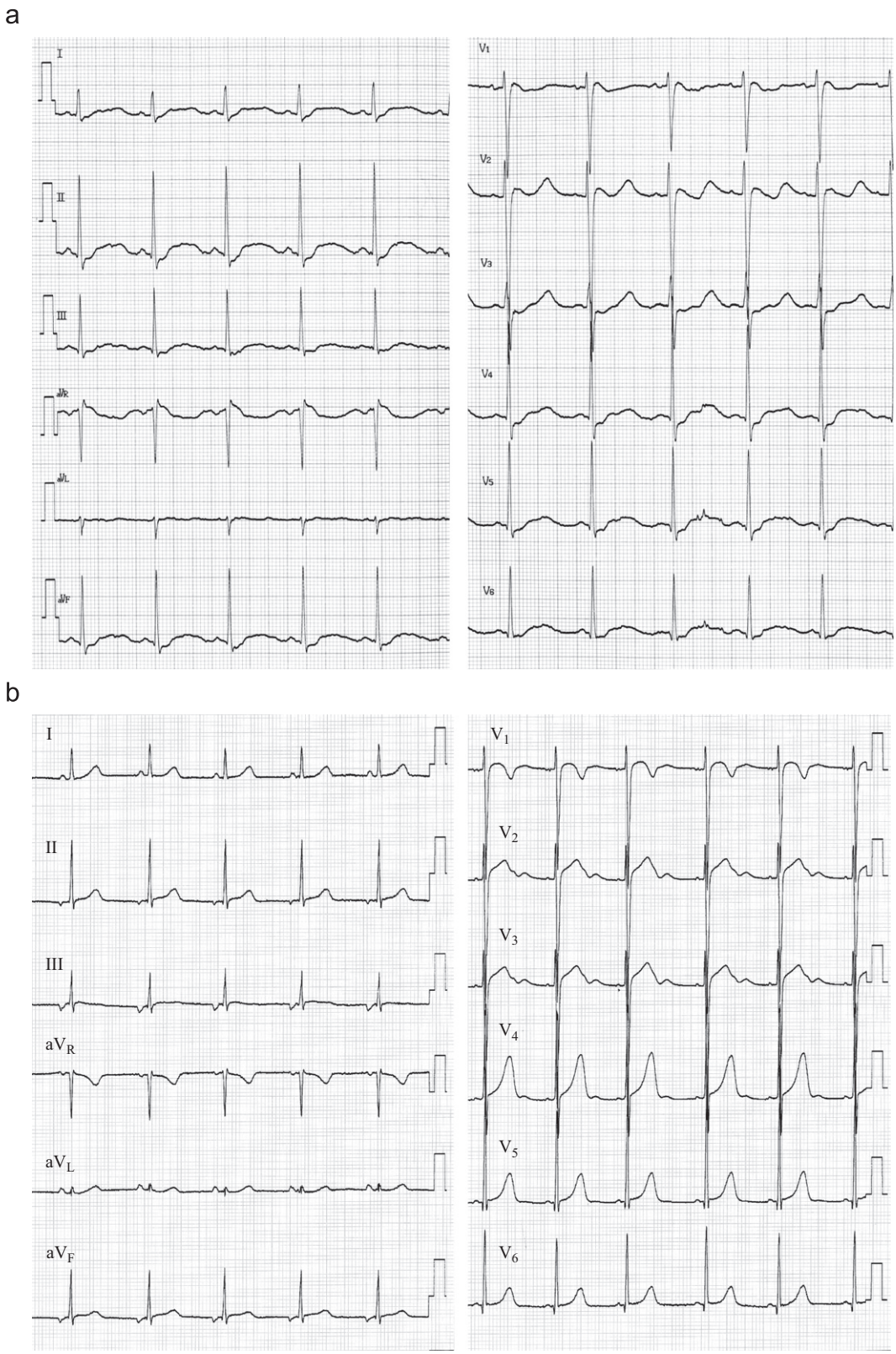

Fig. 1. (a) The patient's resting ECG obtained on August 31, 2008 showed a QTc of 0.665 by Bazett's method and of 0.634 by Fridericia's formula. (b) The patient's ECG obtained on the 25th hospitalization day returned to normal.

Table 1
Serum chemical data: time-dependent changes.

	Day 1	Day 7	Day 13	Day 23
Electrolytes				
K (mEq/l)	1.6	2.2	3.0	3.4
Na (mEq/l)	147	145	145	142
Cl (mEq/l)	97	92	98	104
Aspartate aminotransferase (IU/l)	299	77	30	18
Alanine aminotransferase (IU/l)	200	127	45	14
Lactate dehydrogenase (IU/l)	818	430	246	199
Creatine kinase (IU/l)	15,402	2014	131	41
Blood urea nitrogen (mg/dl)	15.4	14.6	14.6	14.7
Creatinine (mg/dl)	0.67	0.53	0.46	0.40

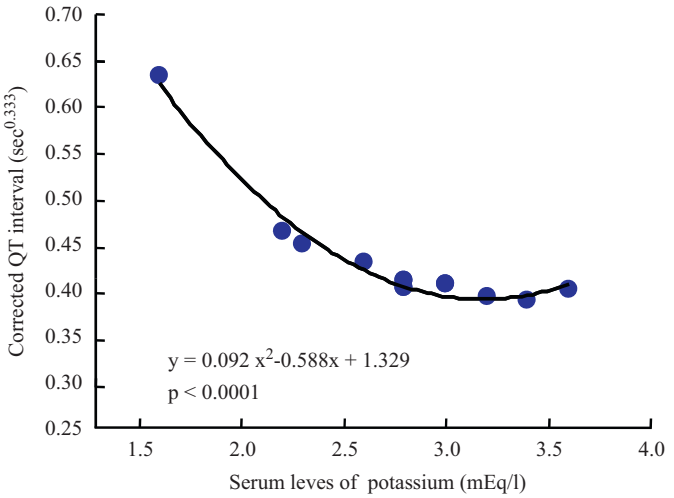

Fig. 2. Association between serum potassium levels and the QTc by Fridericia's formula.

was 140/99 mmHg. A few days later, he recovered from general fatigue and myalgia. On the 23rd day of hospitalization, his ECG (Fig. 1b) and chemical data (Table 1) were normalized, and he was discharged. His corrected QT intervals by Fridericia's formula were significantly associated with serum potassium levels (Fig. 2). The final dosage of drugs was 60 mg/d of spironolactone and 150 mg/d of potassium aspartate, and his blood pressure after control was 120/85 mmHg.

Genomic DNA was isolated from blood after obtaining written informed consent. Genetic screening for LQT-1 (*KCNQ1*), -2 (*KCNH2*), -3 (*SCN5A*), -5 (*KCNE1*), -6 (*KCNE2*), -7 (*KCNJ2*), -9 (*CAV3*), -10 (*SCN4B*), and -12 (*SNTA1*) was performed by PCR and direct DNA sequencing. No mutation was found in these genes.

3. Discussion

Secondary LQTS is caused by several drugs, cardiac conditions, and noncardiac conditions. One of the main metabolic causes is hypokalemia.

A screening program conducted for all Japanese children (1st, 7th, and 10th grades) revealed that a large number of children had LQTS without a positive family history and with no history of LQTS-related cardiac events at the time of diagnosis [5]. The prevalence of abnormal ECG phenotypes, namely, those of abnormally prolonged QT intervals irrespective of the presence or absence of symptoms and/or family history, is estimated to be 1 in 1164 among 7th graders aged 12 years [6].

The association between the prolonged QTc values and hypokalemia is well known [4]; however, the association between the QT interval and serum potassium concentrations in patients with primary aldosteronism may be controversial. Yang et al. reported that there was no significant correlation ($p=0.196$) between the longest QT intervals and the serum potassium concentration in 26 patients with primary aldosteronism [7]. On the other hand, Matsumura et al. reported that the QTc intervals were significantly correlated with serum potassium concentration ($p=0.0011$) before adrenalectomy and that the prolonged QTc values were normalized after adrenalectomy in 19 patients with primary aldosteronism [8]. In the present case, the QTc interval normalized along with the elevation of the serum potassium concentration, and a significant association was present between the QTc values and the potassium concentration. The findings of Matsumura et al. and the present case may support the notion that hypokalaemia prolongs the QTc interval in patients with primary aldosteronism.

The prevalence of acquired or secondary LQTS is unclear in the pediatric field, and very few children or

adolescents receive medications capable of causing drug-induced LQTS. When we, pediatricians, examine patients with LQTS, we tend to think that their LQTS is congenital in nature. However, secondary or acquired LQTS should be always taken into consideration and ruled out.

Conflict of interest

All authors have no conflicts of interest to declare.

References

[1] Schwartz PJ. The long QT syndrome. Curr Probl Cardiol 1997;226: 302–51.
[2] Golderberg I, Moss AJ. Long-QT syndrome. J Am Coll of Cardiol 2008;51:2291–300.
[3] Shimizu W. Clinical impact of genetic studies in lethal inherited cardiac arrhythmias. Circ J 2008;72:1926–36.
[4] Camm AJ, Malik M, Yap YG. Acquired long QT syndrome. Oxford: Blackwell; 2004 (p. 60–181).
[5] Yoshinaga M, Kamimura K, Fukushige T, et al. Face immersion in cold water induces prolongation of the QT interval and T-wave changes in children with non-familial long QT syndrome. Am J Cardiol 1999;83:1494–7.
[6] Fukushige T, Yoshinaga M, Shimago A, et al. Effect of age and overweight on the QT Interval and prevalence of long QT syndrome in children. Am J Cardiol 2002;89:395–8.
[7] Yang TY, Cheng NJ, Ko YS, et al. QT interval is prolonged but QT dispersion is maintained in patients with primary aldosteronism. Int J Clin Pract 2007;61:392–6.
[8] Matsumura K, Fujii K, Kansui Y, et al. Prolongation of the QT interval in primary aldosteronism. Clin Exp Pharmacol Physiol 2005;32: 66–9.